The Health Behavior Schedule-II for Diabetes Predicts Self-Monitoring of Blood Glucose

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Abstract

The Health Behavior Schedule-II for Diabetes (HBS-IID) is a 27-item questionnaire that was evaluated as a predictor of self-monitoring of blood glucose (SMBG). The HBS-IID was completed by 96 adults with Type 2 diabetes. Recent glycosylated hemoglobin HbA1c and fasting blood glucose results were taken from participants' medical records. Only 31.3% reported to be "very successful" in complying with prescribed SMBG. Seventy-one percent of the variance in compliance to SMBG was predicted by four HBS-IID items designed to measure general self-care skills, having promised someone to do so, self-reinforcement for doing so, and not finding it punishing. Each of the HBS-IID predictors has implications for compliance enhancement strategies.
Key Words: compliance, self-monitoring blood glucose (SMBG), Health Behavior Schedule-II for Diabetes (HBS-IID), Basic Behavioral Repertoires (BBRs), facilitating conditions/discriminative stimuli (FC/SD)

Introduction

Self-monitoring of blood glucose (SMBG) is a standard component of self-care for adults with Type 2 diabetes (Winter, 2004). However, compliance estimates are only 5% to 44% (Kennedy, 2001) with lowest rates reported by patients who are not using medication (Harris, 2001). These compliance rates are lower than the 40% to 70% estimates for self-management of many other chronic illness regimens (Christensen, 2004), indicating that SMBG is particularly difficult to acquire.

SMBG provides information that is expected to prompt changes in food consumption, exercise, and medication timing and dosage (Bjorsness, Krezowski, Harwell, McDowall, Butcher, Helgerson, & Gohdes, 2003). In some studies, SMBG has been associated with better glycemic control while in other studies it has not (Harris, 2001). The mixed findings may be due to failure to use the SMBG information to change self-care and because SMBG is only one component of an effective diabetes treatment regimen, while other components may include medication, diet, and exercise (foot care would not be expected to effect glycemic control). For example, one study found only a third of people with Type 2 diabetes comply with taking medication as prescribed, which in and of itself affects glycemic control (Donnan, MacDonald, & Moris, 2002). The purpose of our study was to assess environmental and behavioral competency variables that may indicate which evidence-based treatments may enhance compliance to SMBG.

The low compliance rate for SMBG is not surprising from consideration of the nature of the consequences involved. SMBG generally does not involve external positive reinforcement except possibly in the form of engineered contingent praise. The test results indicating one has obtained a targeted level of glycemic control could function as reinforcement if such information is understood by and pleasing to the individual. The test results, however, could function as punishment for SMBG if they suggest an unhealthy consequence of one's preferred diet, exercise, and medication usage. Moreover, the SMBG procedure involves cutting oneself with a lancet in order to obtain a blood sample, which for some people could constitute punishment for compliance. Therefore, the determinants SMBG as part of the

self-control skills involved in diabetes self-care are likely to include situational factors and behavior repertoires that compensate for less than optimal inherent consequences.

This study was guided by the Health Compliance Model-II (HCM-II; Heiby & Frank, 2003; Heiby & Lukens, 2006; Heiby, Lukens, & Frank, 2005) to identify potential situational and behavioral causal variables for SMBG. The HCM-II was developed in accordance with a psychological behaviorism framework (Staats, 1996). The HCM-II includes facilitating conditions/discriminative stimuli (FC/SD), consequences, organic conditions, and four somewhat overlapping basic behavioral repertoires (BBRs) that determine compliance to health related activities. The four BBRs are sensory-motor, language-cognitive, emotional-motivational, and verbal-emotional. The latter two BBRs involving emotional responses are deemed critical for self-control of all health related activities because they elicit affect, direct approach and avoidance, and determine what constitutes reinforcement and punishment for an individual.

The HCM-II led to the development of a questionnaire, the Health Behavior Schedule-II (HBS-II), which has accounted for 38% to 65% of the variance in compliance to 12 commonly recommended health-related behaviors (i.e., breast self-exam, pelvic exam, not smoking, wearing a bike helmet, sun protection, use of seat belt, moderate alcohol consumption, safe-sex, regular exercise, and low fat high fiber diet) Frank, Heiby, & Lee, in press). Similar results were found with a German language version of the HBS-II (Lukens, Heiby, & Barkhoff, 2005). Compliance on the HBS-II is measured by retrospective self-report, which has external validity support using daily self-monitoring as the criterion (Lukens, Heiby, & Barkhoff, 2006). Each variable measured on the HBS-II is subject to manipulation by an evidence-based treatment and amenable to assessment by retrospective self-report. Thus, not all variables posited in the HCM-II are assessed on the HBS-II. As examples, the assessment of organic factors would require medical tests and assessment of reinforcement contingencies would require direct observation.

The present study evaluated the ability of an adapted version of the questionnaire, the Health Behavior Schedule-II for Diabetes (HBS-IID) to predict SMBG among outpatient adults diagnosed with Type 2 diabetes. The HBS-IID assesses some FC/DS and aspects of the four BBRs.

Figure 1. **Health Behavior Schedule-II for Diabetes**

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1. What is your gender? **M F**

2. What year were you born? _____

3. Do you have Type- 2 (adult-onset) diabetes? **Yes No**

4. Do you use a machine (e.g., Accucheck®) to check your glucose levels? **Yes No** If no, please stop here

5. How often are you supposed to check your glucose levels? ____**times a day** ____**times per month**

6. How successful have you been at making this a habit? (e.g., checking your glucose levels regularly) not at all successful **1 2 3 4** very Successful

7. Compared to other people, I'm pretty good at taking care of myself not at all **1 2 3 4** very much

8. When it comes to checking my blood sugar, I get support from other people **1 2 3 4**

9. Getting to the doctor's office is inconvenient not at all **1 2 3 4** very much

10. Checking my blood sugar causes discomfort		**1**	**2**	**3**	**4**	
11. It is my goal to check my blood sugar levels at home	not at all	**1**	**2**	**3**	**4**	very much
12. I lead an active lifestyle (i.e., I'm engaged in many daily activities)		**1**	**2**	**3**	**4**	
13. I understand why home glucose monitoring is important to my health	not at all	**1**	**2**	**3**	**4**	very much
14. I have promised someone that I'll take good care of my diabetes		**1**	**2**	**3**	**4**	
15. Of all things important to me, my health is most important	not at all	**1**	**2**	**3**	**4**	very much
16. I am able to follow my doctor's instructions for home glucose monitoring		**1**	**2**	**3**	**4**	
17. Home glucose monitoring is inconvenient	not at all	**1**	**2**	**3**	**4**	very much
18. Without home glucose monitoring, my health would be at serious risk		**1**	**2**	**3**	**4**	
19. It makes me feel good to keep close track of my blood sugar	not at all	**1**	**2**	**3**	**4**	very much
20. I intend to monitor my own blood sugar levels at home		**1**	**2**	**3**	**4**	
21. I get nervous before receiving any new information about my health	not at all	**1**	**2**	**3**	**4**	very much
22. My doctor told me to monitor and record my blood sugar levels at home		**1**	**2**	**3**	**4**	
23. I am good at reminding myself to stay on track with daily responsibilities	not at all	**1**	**2**	**3**	**4**	very much
24. If something were terribly wrong with my health, I'd rather not know		**1**	**2**	**3**	**4**	
25. I am motivated to keep my diabetes in excellent control	not at all	**1**	**2**	**3**	**4**	very much
26. If I skipped doing one of my blood sugar checks, I'd feel bad about it later		**1**	**2**	**3**	**4**	
27. Home glucose monitoring is boring	not at all	**1**	**2**	**3**	**4**	very much

Method

Subjects

Participants were 96 adults with Type 2 diabetes who were attending an outpatient medical clinic located in the City and County of Honolulu, Hawaii USA. The distribution of sex of the participants was 44% (n = 42) male and 56% (n = 54) female. The mean age was 60 (SD = 10) years. Participants were prescribed to SMBG on average 10.30 (SD = 5.91) times per week. All participants reported owning a SMBG portable device.

Materials

The Health Behavior Schedule-II for Diabetes (HBS-II-D; see Table 1) is a 27 item self-report questionnaire including 5 demographics, 21 predictors, and one rating of compliance to SMBG as prescribed. Items 1 through 5 measure demographics. Item 6 measures degree of compliance to prescribed SMBG.

Table 1.
Stepwise Regression Analyses with Compliance as the Outcome

	Step	R^2	Change in R^2	*P*	Beta
1	Self-care (Item 7)	.533	.533	<.001	.350
2	Promise (Item 14)	.622	.089	<.001	.286
3	Self-reinforce (Item 19)	.680	.058	<.001	.249
4	Punishing (Item 10)	.708	.028	.004	-.196

***Note*: F for all models $p < .001$; Item 7 is sensory-motor; Item 14 is facilitating condition/discriminative stimulus; Item 19 is verbal-emotional; Item 10 is emotional- motivational**

Items 7 through 27 measure FC/SD and BBRs that have been shown to predict other health-related habits on the HBS-II (Frank et al., in press). The variables assessed by these 21 items are as follows: general self care skills (item 7), social support for SMBG (item 8), ease of access to physician's office (item 9), discomfort from or punishing aspects of SMBG (item 10), having the goal to SMBG (item 11), activity level and time management skills (item 12), understanding the reasons for SMBG (item 13), expectations and presumably prompts from having promised someone to follow the diabetes self-care regimen (item 14), relative importance of health to the individual (item 15), self-efficacy or perceived ability to SMBG (item 16), inconvenience related to SMBG (item 17), perceived severity of health consequences for failing to SMBG (item 18), self-reinforcement for SMBG (item 19), intention to SMBG (item 20), anxiety elicited by health status information (item 21), being instructed to SMBG (item 22), use of prompts and reminders for daily activities (item 23), avoidance of negative health related information (item 24), motivation to comply to the diabetes self-care regimen (item 25), self-punishment for failure to SMBG (item 26), and whether SMBG is perceived to be boring (item 27).

FC/SD are measured by items 8, 9, 14, and 22. The language-cognitive basic behavioral repertoire is measured by items 13 and 20. The emotional-motivational repertoire is measured by items 10, 15, 17, 21, 24, 25, and 27. The verbal-emotional repertoire is measured by items 11, 16, 18, 19, and 26. The sensory-motor repertoire is measured by items 7, 12 and 23.

Clinic medical records provided the results of the most recent blood test indicators of glycemic control in terms of glycosylated haemoglobin HbA1c and fasting blood glucose.

Procedure

While in a medical clinic waiting room, participants completed a consent form (two copies) and the HBS-IID, which took approximately five minutes. Patients were instructed to keep one copy of the consent form and give the other copy and the HBS-IID to clinic staff. Results of two blood test indicators of glycaemic control were obtained from medical records by clinic staff and noted at the bottom of the completed HBS-IID. The remaining consent form was then detached from the questionnaire and filed separately in order to maintain anonymity of HBS-IID responses and blood test results. This procedure was approved by the University of Hawaii's institutional review board.

Results

The internal consistency reliability estimate for 20 of the 21 predictors (items 7 through 27) on the HBS-IID was .80 after removing item 24, which had a nonsignificant correlation with the total score.

Construct validity of the HBS-IID was supported by significant correlations in the expected direction between compliance to prescribed SMBG (item 6) and all but two HBS-IID predictors (items 22 and 24). Significant correlations ranged from .73 ($p < .001$) to -.57 ($p < .001$).

Criterion validity for item 6 was supported by significant negative correlations between degree of compliance to SMBG and both HbA1c (R = -. 27; p < .01) and fasting blood glucose (R = -.46; p < .001) results.

Rates of compliance to SMBG as prescribed (item 6) were 31.3% (n = 30) *very successful*, 24% (n = 23) *somewhat successful*, 21.9% (n = 21) *rarely successful*, and 22.9% (n = 22) *not at all successful.* The mean score on a four-point scale was 2.64 (SD = 1.15) with 4 indicating *very successful*. The correlation between rate of compliance and the number of times per week SMBG was prescribed (item 5) was not significant.

HbA1c and fasting blood glucose indicators were normal for 15.6% (n = 15) and 13.5% (n = 13) respectively. An HbA1c assay of less than 7% was deemed normal (UKPDS, 1998) while a fasting blood glucose of 64 through 110 mg per deciliter (Tirosh, Shai, Tekes-Manva, Isreli, Pereg, Shochat, Kochba, & Rudich, 2005) was deemed normal.

As reported in Table 1, a stepwise multiple regression (with item 24 omitted) indicated that four of the remaining 20 HBS-IID predictor items significantly accounted for 71% of the variance of compliance to prescribed SMBG (item 6). The predictor items were designed to measure (in descending order of variance accounted for) general self-care skills (item 7), having promised someone to perform SMBG (item 14), self-reinforcement for SMBG (item 19), and finding that SMBG is not punishing in terms of causing discomfort (item 10).

Two additional stepwise multiple regressions were conducted to ascertain if the 20 reliable HBS-IID predictor items could account for significant variance in glycaemic control. Finding that SMBG is not punishing in terms of causing discomfort (item 10) accounted for 19.8% of the variance of HbA1c results (F = 15.21, d.f. = 94, p = .000). Use of prompts and reminders for daily activities (item 23) accounted for 13.7% of fasting blood glucose indicators (F = 14.81, d.f. = 94, p = .000).

Discussion

The results support the internal consistency reliability and construct validity of the HBS-IID, excluding item 24. The HCM-II's prediction that emotion-eliciting variables are critical to compliance to SMBG was also supported in terms of items 10 (emotional-motivational punishing aspects of SMBG) and 19 (verbal-emotional self-administered reinforcement for SMBG).

The four HBS-IID variables that significantly accounted for SMBG may be modifiable by evidence-based psychological treatments (Heiby & Frank, 2003; Heiby & Lukens, 2006; O'Donohue, Fisher, & Hayes, 2003) that might enhance compliance to prescribed SMBG. Given that only 31.3% of the respondents reported being very successful with this self-control skill involved in diabetes management, the need for behavioral health counseling designed to enhance compliance is clearly indicated. The HBS-IID may help to identify "at risk" individuals who are most in need of compliance-enhancing interventions. Because the rate of compliance was not found to be significantly related to the frequency of prescribed SMBG, these risk factors may be relevant to a range of diabetes patients. However, rate of compliance was measured by a global retrospective self-report item that, while convenient and inexpensive, may result in over-reporting due to factors such as demand characteristics and faulty memory (Fernandez-Ballesteros, 2004; Levensky & O'Donohue, 2006; Stone, Turkkan, Bachrach, Jobe, Kurtzman, & Cain, 2000). Retrospective self-report also fails to identify temporal patterns of compliance (Riekert, 2006) that could be related to frequency of prescribed SMBG.

The HBS-IID predictor item 7 was designed to measure general self-care skills (including behavioral change prompted by SMBG results). These primarily sensory-motor skills may be improved with modeling, behavior rehearsal, and shaping procedures. Item 14 was designed to measure having someone who expects the patient to comply with SMBG and possibly provides an environmental prompt to do so. This FC/SD may be modified by behavioral engineering of the patient's social support network so prompts are provided at an optimal rate. Use of social support in maintaining diabetes self-care has been referred to as an ecological approach to diabetes management (Fisher, Brownson, O'Toole, Anwuri, Shetty, & Rubin, 2006). Item 19 was designed to measure self-reinforcement for SMBG. This verbal-emotional skill may be learned with self-control or self-management training. Finally, item 10 was designed to measure the emotional-motivational characteristic of finding SMBG to not be punishing. Decreasing the aversive aspect of SMBG may be accomplished by desensitization and emotion regulation skills training. This finding is consistent with studies using the Problem Areas in Diabetes scale that indicate managing the distress associated with self-care contributes to compliance (Polonsky, Fisher, Earles, Dudl, Lees, Mullian, & Jackson, 2005; Welch & Guthrie, 2002).

It is noteworthy that the two language-cognitive variables assessed on the HBS-IID (understanding the purpose of and having the intention to engage in SMBG) were not predictive of compliance in the present study. These results suggest that educational programming for enhancement of compliance to SMBG may not be targeting the essential skills and situational factors needed to acquire this habit. For example, explaining the purpose of SMBG may need to also include training in problem-solving skills (Oser, 2006) regarding changes in eating, exercise, and medication indicated by blood glucose levels.

It is also noteworthy that the verbal-emotional variable of self-efficacy did not significantly account for variance in SMBG. In contrast, self-efficacy did significantly account for variance in compliance to all of the 12 health related practices studied using the English and German language versions of the HBS-II (Frank et al., in press; Lukens et al., 2005). This finding suggests caution in generalizing the effect of self-efficacy, particularly for a potentially painful activity such as SMBG.

The results of this study suggest that a five-item version of the HBS-IID deserves investigation as a means of identifying factors that contribute to noncompliance to SMBG that are amenable to prevention and treatment programming. A shortened version of the HBS-IID would include item 6 (compliance) and predictor items 7 (general self-care skills), 10 (discomfort), 14 (promising others), and 19 (self-reinforcement). Scores less than four on the compliance item could indicate the patient is lacking some skills necessary to learn SMBG. Scores less than four on any of the four predictor items could serve as a basis for investigating the effects of the interventions suggested by the variable assessed on each item.

Prediction of glycemic control in terms of HbA1c and fasting blood glucose test results by HBS-IID items is difficult to interpret because control may be due to factors other than SMBG. Nevertheless, the findings suggest that reducing the emotional-motivational discomfort of SMBG (item 10) and use of FC/SD in terms of prompts to remind oneself to SMBG (item 23) may be essential to a diabetes self-care regimen that also includes medication, diet, exercise, and foot care.

Prior research on the HBS-II on 12 commonly prescribed health related behaviors suggests that different predictor items are relevant to different health behaviors (Frank et al., in press; Lukens et al., 2005). Therefore, future studies may suggest compliance enhancement strategies specific to each aspect of the diabetes self-care regimen. After improvement of the internal consistency reliability of item 24, we believe that the entire HBS-IID deserves further investigation by inclusion of additional aspects of compliance to the diabetes self-care regimen, such as taking medication as prescribed, engaging in regular exercise, eating a diabetic diet, practicing daily foot care hygiene, and using SMBG results to modify certain aspects of the diabetic treatment regimen as instructed by a physician.

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